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Mussel Watch Sampling Procedures and Site Descriptions for Oregon State

NOAA National Centers for Coastal Ocean Science
Stressor Detection and Impacts Division

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.

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NOAA NCCOS Stressor Detection and Impacts Division

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National Centers for Coastal Ocean Science (NCCOS)
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Silver Spring, MD
USA

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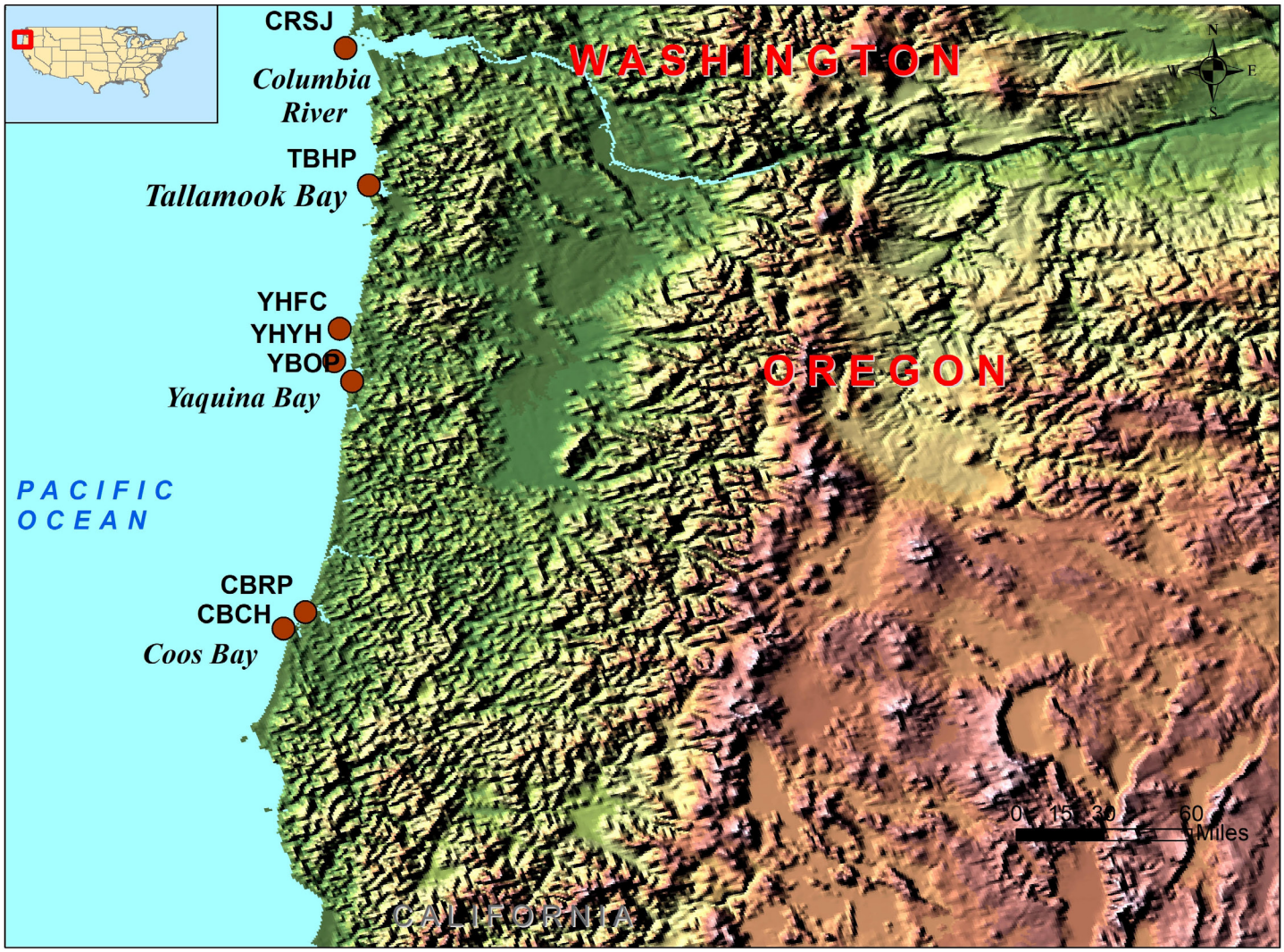

Mussel Watch 2019 Oregon Sites

OVERVIEW

National Status and Trends (NS&T) Mussel Watch Program provides status of and temporal trends of coastal contaminant conditions. Bivalve tissues are analyzed for a suite of about 600 legacy and emerging chemicals of concern. In addition, bivalve tissues are assessed for histopathology and gonadal index. The Program's data, metadata and information products are managed within the guidance provided by NOAA's Integrated Ocean Observing System (IOOS) and the National Monitoring Network, as recommended by the 2004 Ocean Action Plan. This document describes the Standard Operating Procedure (SOP) for mussel collections in Oregon State. Since 1986, Mussel Watch has established about 300 sites nationwide and 9 of these are in Oregon State (Table 1). Site descriptions can be found in Appendix 4. Detailed descriptions of the National Mussel Watch Program field manual are provided in Apeti, et al. (2012).

ACKNOWLEDGEMENTS

Mussel Watch acknowledge Chris Caldow from NOAA for making this collaboration possible and the Oregon Department of Fish and Wildlife for their field support. Also the Mussel Watch Team would like to thank those who through their hard work have established and broadened Mussel Watch sites in the Pacific Northwest. As a result of their efforts, Mussel Watch has been greatly enhanced.

Roger Fay	TDI-Brooks International, Inc.
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Dave Fox	Oregon Department of Fish and Wildlife
Steven S. Rumrill	Oregon Department of Fish and Wildlife
Volunteer Groups	Oregon Department of Fish and Wildlife Oregon Department of Environmental Quality

1. METHOD SUMMARY

Successful and efficient Mussel Watch sampling requires careful planning and preparation. Field teams must be competent in their ability to navigate precisely to the sampling site (use GPS), by the appropriate means (auto, boat, on foot), at the precise time (usually low tide), with the proper equipment, return safely with samples that have been carefully protected from deterioration and contamination, then properly ship the samples to laboratories with documentation.

Mussel Watch sites vary in regards to their accessibility, and mode of sampling. Therefore, knowledge of existing site description and accessibility is essential prior to conducting sampling. Mussel Watch sites are assigned target latitude and longitude coordinates. Field crews should use GPS to locate sites and report the actual sampling coordinates with each site visit. Collection date and time should be selected to meet the target date and tide criteria. Collections should be within 3 weeks of the target collection date (Table 1).

For intertidal sites the time must correspond to a tidal stage when bivalves are easily accessible. Height of collection (above the water level at the time of collection) and height of the highest bivalve distribution is information to be recorded at the time of collection.

Federal and state sampling permits (Appendix 1) or permission to access private property may take weeks to obtain. The process should begin six to eight weeks prior to the desired start date. This is also the time to begin communication with the Mussel Watch Program Staff and the laboratories that will be receiving the samples (Appendix 1) and provide them with a list of where (site codes and site names) and when (date and low tide prediction) the field team plans to sample. The Mussel Watch sites in Oregon State are described in detail in Appendix 4.

Mytilus galloprovincialis/trossullus – sometime defined as Mytilus sp. for species complex - and Mytilus californianus are typically found at Mussel Watch sites throughout the Pacific Northwest coastal area (Figure 1 and Table 2). Permit requests should specify both species.

Figure 1. Images of *Mytilus* species mussels.

Table 1. Table of Mussel Watch sites in Oregon indicating site locations, and target sampling dates

Site Code	General Location	Specific Location	State	Target Date
CBCH	Coos Bay	Coos Head	OR	12-Dec
CBRP	Coos Bay	Russell Point	OR	12-Dec
YBOP	Yaquina Bay	Oneatta Point	OR	12-Dec
YHYH	Yaquina Bay	Yaquina Head	OR	12-Dec
YHSS	Yaquina Bay	Sally's Slough	OR	12-Dec
YHFC	Yaquina Bay	Fogarty Creek	OR	13-Dec
TBHP	Tillamook Bay	Hobsonville Point	OR	11-Dec
CRSJ	Columbia River	South Jetty	OR	15-Feb
CRYB	Columbia River	Youngs Bay	OR	15-Feb

Table 2. Table of Mussel Watch sites in Oregon indicating target species

Site	General location	Specific location	Target species	Datum	Latitude	Longitude
CBCH	Coos Bay	Coos Head	Mytilus californianus	NAD83	43.3500	-124.3308
CBRP	Coos Bay	Russell Point	Mytilus species	NAD83	43.4313	-124.2212
YBOP	Yaquina Bay	Oneatta Point	Mytilus species	NAD83	44.5752	-123.9890
YHYH	Yaquina Bay	Yeaquina Head	Mytilus californianus	NAD83	44.6763	-124.0780
YHFC	Yaquina Bay	Fogarty Creek	Mytilus californianus	NAD83	44.8370	-124.0520
TBHP	Tillamook Bay	Hobsonville Point	Mytilus species	NAD83	45.5472	-123.9075
CRSJ	Columbia River	South Jetty	Mytilus species	NAD83	46.2287	-124.0232

2. PLANNING AND PREPARATION

This section lists tasks that should be accomplished prior to entering the field. When sampling begins the field team should communicate with the Program Manager on a daily basis or other previously agreed upon schedule. Clear and timely communication with Mussel Watch staff and laboratories receiving the samples are critical.

Deviations from the SOP are sometimes necessary but approval from the Program Manager should be obtained prior to sampling. If prior approval is not possible, notification of Program staff should be done as soon as possible. In every case, changes in sampling procedures or location must be clearly documented by the field crew.

2.1 Four to eight weeks prior to entering the field:

- Review the site descriptions (Appendix 4);
- Contact NOAA staff and identify sites to be sampled (Appendix 2);
- Prepare a sampling schedule based on tide prediction tables.
- Check travel time between stations and mode of transportation (ferry schedules, or boat support);
- Site access considerations (e.g., private property, boat support requirements, etc.);
- Check staff experience in environmental sampling, if possible provide training and review procedure;
- Ensure the communication means (cell phone, marine radio, other) are in place;
- Request sampling permits and/or permission to access private property (Appendix 2);
- Order necessary equipment and supplies;
- Review instrument operating procedures and calibration, and confirm equipment is operating correctly (Table 3);
- Contact laboratories that will be receiving the samples or doing the analyses and provide them with your tentative sampling schedule, as well confirming confirm their availability to receive the shipment.

Table 3. List of sampling equipment and supply

Item	Quantity	Description and Use
ELECTRONICS		
Handheld GPS	1 plus backup	Set datum to NAD83; Become familiar with the GPS unit
Water Quality Meter	1 plus backup	Measure water salinity, temperature and dissolved oxygen
Digital Camera	1 plus backup	Site documentation. Set to local time and date
SAMPLING & SHIPPING SUPPLIES		
Clam rake, epibenthic dredge, or other appropriate bivalve collecting equipment	1 plus backup	Some site may require a rake to sample bivalves
Gloves, Kevlar	2 pairs/person	For protection when removing bivalves from substrate
Gloves, nitrile (unpowederd)	As needed	To protect sample from contamination when sorting
Data Sheets	As needed	For field documentation
Chain of Custody Forms	As needed	
1 gallon Ziploc bags	1 box/5 sites	Samples are to be double bagged
Clipboard (with paper storage)	1	
Pencils	1 box	Filling forms
Sharpies	2 box	Regular tip for labeling samples bags and fine tip for data sheets
Ball Point Pens	1 box	For filling out shipping forms (air bills)
1 inch wide Strapping Tape	1 roll / 5 sites	Nylon reinforced tape to keep cooler lids from opening during shipping
28 Qt Cooler (no drain port)	1 / 5 sites	Used for shipping samples to chemistry laboratory
16 QT Cooler (no drain port)	1 / 5 sites	Used for shipping samples to histopathology laboratory
48 QT Cooler (with drain port)	1 or 2	Used for storing samples on ice (drain port open to allow melt water to drain) pending transfer to shipping coolers
28 Qt Crate	1 or 2	For packing field supplies
Bucket	1 or 2	Used with ambient water to wash the bivalves
Stainless steel Knives	1 / person	Used to safely detach bivalves
Brush	1 or 2	Used to remove debris from bivalves
Shipping Labels	As needed	One air bill label per shipping cooler
Paper Towels	As needed	
Wet Ice	As needed	Used in the field and for packing samples
Blue Ice	As needed	Can be substituted for wet ice if necessary
Road Maps	As needed	
NOAA Charts	As needed	

2.2 Planning Resources

- Tide predictions: http://tidesandcurrents.noaa.gov/tide_predictions.shtml

- Weather forecast: http://www.wrh.noaa.gov/sew/

3. FIELD DOCUMENTATION

All Mussel Watch sites must be described with the following information (Appendix 2): site code and name, date, time, temperature, coordinates, datum (NAD83) reported to the nearest 0.000001 decimal degree, photographs, etc. It is equally important to record any additional relevant information (concerns and dangers that should be noted by subsequent field teams). Also, it is imperative to provide written descriptions of how to reach newly established site, photographs of the site, and complete site description including collection method, access, permits, safety issues, tide and currents, sea state. A sample data sheet is provided in Appendix 2.

4. SAMPLING METHOD

4.1 Personal Safety

Coastal environments can be dangerous and unpredictable; exercise due caution.

- Do not sample alone. Use a minimum of two people; three is preferable.
- Wear appropriate clothing for thermal and water protection. “Cold Water Kills.” Review coldwater safety prior to entering the field.
- Be alert to breaking waves; use a spotter with a throw line; wear a PFD if appropriate.
- Avoid falls; wet rocks and logs are slippery.
- Wear gloves: protect hands from cuts (Kevlar) and samples from contamination (nitrile).

Field teams should use good judgment and not risk their personal safety when conditions pose undue risk. Abandon the site and return when conditions improve.

4.2 Site location

Use a handheld GPS (NAD83 datum) to navigate to the sampling site. Samples are to be collected at three stations to constitute a site composite sample. It is therefore important to accurately determine the “center of each bivalve site” (if not coincident with the bivalve site). Although, relevant information (distance and relative position from the site center, abundance, substrate ect) may be described, only information from the first station (center) should be recorded as part of the field documentation.

4.3 Water Quality and Height of Collection

Use a water quality meter (e.g., YSI or Hydrolab) to measure and record physical parameter of the water (salinity and water temperature). For salinity determination, it is recommended to use a temperature compensated refractometer measurement (Appendix 3). All field equipment should be tested and calibrated as required by the manufacturer prior to beginning field work . A detailed account of field-QC check and calibration of instruments customarily utilized during Mussel Watch field work (e.g. YSI, Hydrolab or similar meter) is described in the EMAP Quality Assurance Plan (EPA, 2001). All field-QC check procedures must be appropriately documented including dates and name of the person conducting the procedures.

Height of collection refers to the height above the water level at the time of collection. Estimate the “height of collection” as being the height above the water level at which mussels are available for collection. For example if samples are collected three feet above the water level sample height is indicated as 3 or if samples are collected at water level, the height of collection is 0. The other value is

height of highest access. For example, bivalves are at current water level, but you note that they are available up the intertidal zone (the vertical extent which is washed by the tides) all the way up to approximately 6 feet above the current water level, then the Highest Access is 6 feet. On the other hand if collection was conducted at water level of 0 feet, but there were no other bivalve beds, the Height of Highest Access in this instance is also 0 feet. Access in this instance is also 0 feet. By correlation with time of collection and a graphical depiction of the tide, the tide stage can be determined. Reporting time and tide stage of when specimens are expected to be accessible is very helpful for future collections.

4.4 Bivalve Collection

4.4.1 Existing Mussel Watch Sites

Protective gloves (Kevlar) should be worn to protect hands from cuts. Samples are to be double bagged in Ziploc bags and placed in a cooler with water ice.

At each Mussel Watch site, bivalve samples should be collected from three different stations to constitute the site composite sample. It may not be possible or practical to delimit three separate stations at each site. In such a case, the collection could be made without distinction, but the "picking" should be separated into three stations based on relative spatial distance. The purpose of this is to avoid sampling a single non-representative "clump" of bivalves. Depending on the region, littoral zone (subtidal, intertidal), and depth, sampling techniques differ. Bivalves may be handpicked at low tide in intertidal zones, hand collected or dredged at site located in the subtidal zones.

Collect approximately 100 - 160 bivalves depending on size. The optimal size for *Mytilus sp*. is 5 – 8 cm (2 – 3 ¼ inches). If bivalves are about 1 cm (< ½ inch), collect 160 maximum. Separate locations or stations into individual plastic bags and label accordingly (i.e., A, B, C). Record GPS coordinate for each location. It is always advisable to collect extra mussels when possible for chemistry as extra tissue samples are archived and can be used for future analyses.

A cooler of adequate size should be brought into the field that can hold all the samples, before they are sorted and packaged for shipping. This cooler should contain ice that is kept separate from the samples. The samples in Ziploc bags should be placed on water ice immediately after collection. It is especially important that samples for histopathology and gonadal index not be allowed to freeze as these bivalves must arrive at the laboratory alive.

- Avoid contamination of samples from oil, fuel, pesticide, PCBs, exhaust fumes, flaking or rusty metal. When using a boat for sample collection, make sure that the bilge pump is off when on station.
- Avoid collection of samples on anything other than natural substrates. Untreated concrete and natural rock used for breakwaters are acceptable.
- The specimens' shells should be thoroughly rinsed in water at the site to remove mud and debris which are sources of contamination of the tissues inside.
- Sample bags should be properly labeled to indicate site code and collection date.

4.4.2 Establishing a New Mussel Watch Site

The project manager may direct field team to establish new sites for bivalves. In such cases, the project manager usually provides target latitude and longitude coordinates to locate the new site but may grant the field team the latitude to establish the new site at their discretion. The following section

describes general procedures for establishing a new Mussel Watch site.

Criteria for bivalve site selection:

- Conduct prior reconnaissance of the coastal zone to identify an adequate site with healthy bivalve population such that repeat sampling in later years will be possible.
- Sites should integrate contaminant accumulation from nearby or surrounding areas and should be outside effluent discharge zone unless designated to specifically monitor incoming contaminants.
- Substrates are limited to rock or concrete (including rip-rap and jetties), and sand or mud. Structures such as wooden pilings and metallic navigation aids are avoided in order to eliminate potential point contamination;
- Indigenous populations of bivalves must exist; transplanted organisms are not used except in case for special studies;
- Sites must have sufficient bivalves, such that repeated annual harvesting will not seriously deplete the resource.
- Sites must be suitable for follow-up sampling (e.g., not anticipated to be physically disrupted by development activities or dredging).
- Sites are collected in late fall and winter. Once a site and field sampling methods are established, repeat sampling occurs within ±3 weeks of that sampling date. The rationale for winter sampling is to avoid collecting spawning organisms. Newly established sites are assigned a new site name and unique four letter site code.

The species of mussels collected at each site are chosen based on the location and the predominant species in the area. Once the target species is chosen, every effort must be made to sample that same species.

When a new site is established, samples from the 3 unique stations are analyzed separately. For intertidal sites this would be three locations along 100 m of shoreline. For subtidal sites this would be three stations in a 400 m (radius) area. It may not be possible or practical to collect three separate stations at a new site. In such a case, the collection could be made without distinction, but the “picking” should be separated into three based on relative spatial distance. The purpose of this is to avoid sampling a single non-representative “clump” of bivalves.

5. SAMPLING HOLDING

Bivalves can survive for many days if the conditions are properly maintained. Double bagged samples of bivalve stored in coolers filled with water ice works very well provided melt water is allowed

to drain. Do not allow bagged samples of bivalves to site in melt water. Check coolers regularly for excessive melt water; drain and replenish with water ice as needed. DO NOT allow bivalves to freeze. Use extra caution when ambient air temperatures drop below freezing; ensure iced samples do not get too cold. This is especially important for samples that will be analyzed for histopathology/gonadal index.

Try to ship samples within 24 to 48 hrs of collection. However, experience has shown that it is better to hold bivalve samples as described above over weekends or holidays rather than risk shipping on a Friday with a Saturday delivery and having samples inadvertently sit in too warm of an environment.

6. SAMPLE PACKING AND SHIPPING PROCEDURES

"Sample shipping conditions" are the same as "sample holding conditions" described above with the exception that water ice is double bagged in Ziploc bags to ensure that the melt water is retained and unable to contact the sample bags or to leak from the cooler. If cooler have drain ports tape them shut.

6.1 Packing Samples

Separate the double bagged bivalve samples for chemical analysis from those for histopathology/ gonadal index and place in separate shipping coolers. Coolers that are 48 qt size or smaller may be used for shipping. However, coolers that are 28 Qt (or smaller) are best as these coolers typically do not have drain ports and can be easily handled by one person. Completely fill the entire volume of the cooler with a combination of sample and ice. This will help to minimize sample movement. Water ice should account for at least one-third of the cooler's volume (about 10 lbs of ice for a 28 qt cooler). Gel packs may be substituted for water ice but should account for one-half the cooler volume.

Use the Chain-of-Custody form (Appendix 2) to inventory the samples as they are placed into a shipping cooler. This process is easier and faster when done with two people; one recording and the other handling the samples.

6.2 Shipping

Before sealing the shipping cooler place copies of the chain-of-custody and field data sheet forms in a Ziploc bag and tape it to the inside of the cooler lid. Retain copies for your records.

- Use nylon reinforced strapping tape to securely fasten the cooler lids shut and prevent them from opening when dropped (Figure 2). On both end of the cooler, wrap the tape completely around the cooler (top, sides, and bottom) twice so that tape sticks to itself.
- Attach the courier's air bill to the top of the cooler. Be sure to include cell phone numbers of people in the field (shipper) and the lab (receiver). It is also a good idea to write "to" and "from" addresses directly on coolers. Telephone numbers should be included. This is to ensure contact information is available should the shipping labels become detached from the coolers.
- Deliver shipping coolers to an overnight courier office or authorized agent. Do not leave the shipping coolers at a drop box or a location which is not an authorized agent.

Packaging Mussel Watch Samples for Shipment

1. Bagged ice on bottom with label lay on ice.
2. Drained, bagged samples

3. Bagged samples layered between bags of ice.
4. Bagged ice on top. Fill void with more ice.
5. Three address labels.
6. Sealed with at least two bands of (3 wraps each) fiber tape, and 1 band wide clear tape wide clear tape. Airbill and tag affixed to chest with fiber tape, not handle.

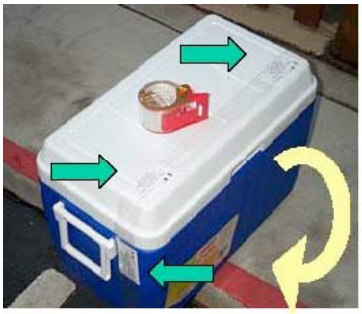
Figure 2. Illustration showing packaging and labeling for sample shipment


1


2


3


4


5


6

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Appendix 1 - Important Contacts

NOAA Contacts

Primary NOAA contact: Dennis Apeti, PhD. - NOAA Mussel Watch Program Manager
(240) 533-0337; (Email) dennis.apeti@noaa.gov

Secondary NOAA Contact: Ed Johnson, PhD. – NOAA Mussel Watch Program
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Amanda Brewster, TDI Brooks
(979) 693-3446; amandabrewster@tdi.bi.com
14391 S Dowling Rd, College Station, TX 77845

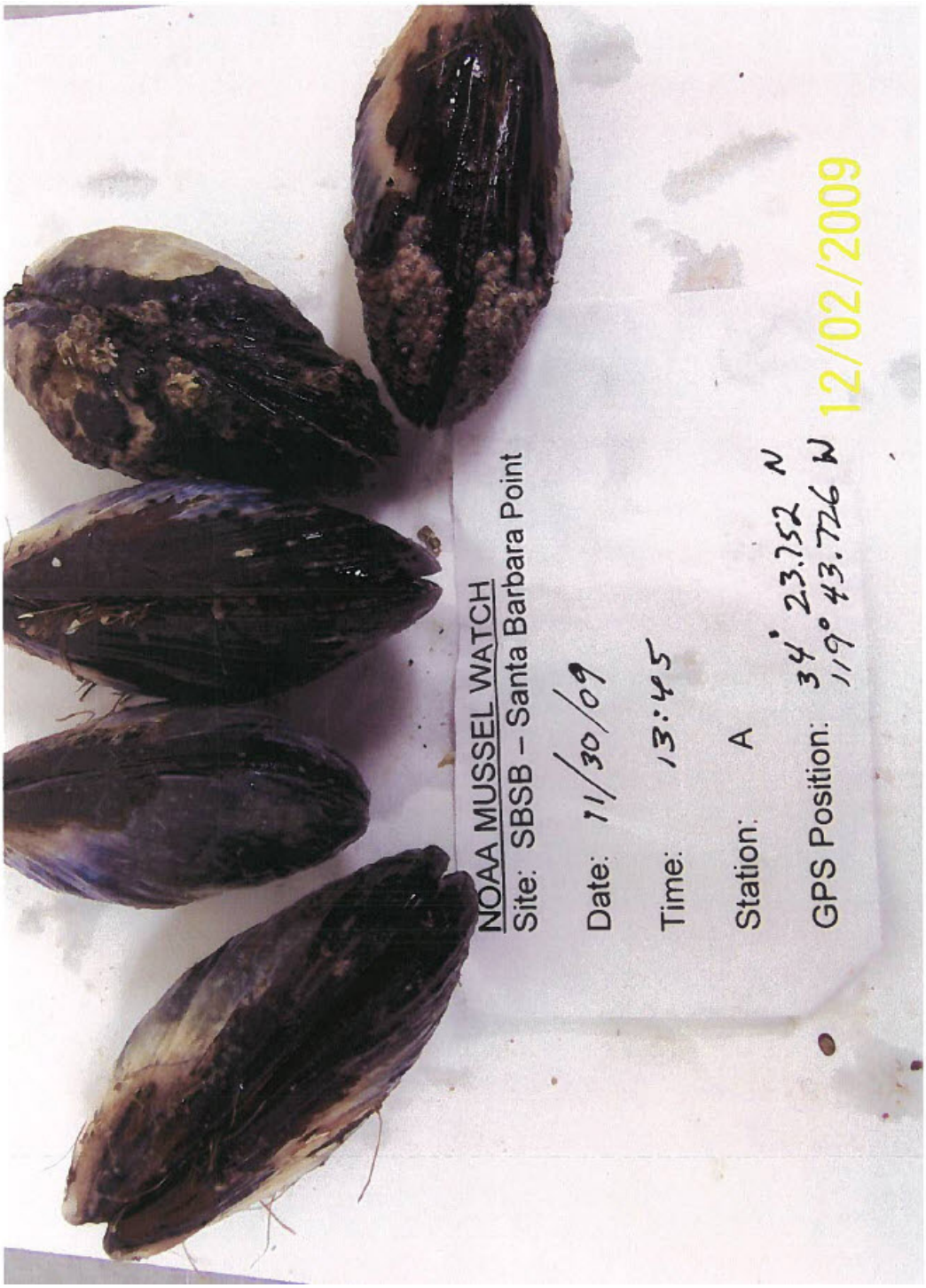
Amanda is the Sample Custodian at the TDI Brooks Laboratory. Keep her informed of upcoming sample collection dates, and the shipment of the samples.

Permit Contacts

Oregon Department of Fish and Wildlife for scientific permit.

Appendix 2 – LABELS, DATA SHEET AND OTHER DOCUMENTATION

Sample Label



Mussel Watch-……. _Oregon_ Sediment Collection

Field Team:	Recorder:

Sediment	**Site Code**	**Alternate**	**Date** (mm/dd/yyyy)	**Time** (local)	**Depth ft/m**

SEDIMENT SAMPLES				# grabs:	
Organics/TOC (250ml)	Metals (250mL)	Sed Tox (250mL)	Grain Size (Whirl)		Other:

STATION LOCATION		GPS:	
Station Coordinates		Discription	
Latitude:			
Longitude:			

WATER QUALITY		Insturment:	
Surface		Bottom - 0.5 m	
Temperature (C):		Temperature:	
Salinity (psu):		Salinity:	
Dissolved Oxygen (mg/L):		Dissolved Oxygen:	
Secchi Depth:			

STATION LOCATION			
GPS:	Station 1	Station 2	Station 3
Latitude (decimal degrees)			
Longitude (decimal degrees)			
Water Depth (meters)			
Tidal Horizon (meters)			

SEDIMENT DESCRIPTION (Check)							
Texture		Color		Odor/Sheen		Benthos	
Silt		Black		None		None	
Clay		Brown		Sulfur		Worms	
Mud		Gray		Sewage		Tubes	
Sticky		Green		Oily		Molluscs	
Sand		Rust		Other		Crustacea	
Shell/Rock		Other				SAV	
Other						Algae	
						Other	

Other Comments: (Comments: (e.g. photos, sources, weather/seas, access…)

Mussel Watch-…. _Oregon_ Bivalve Collection

Field Team:	Recorder:

Target Species	**Site Code**	**Alternate**	**Date** (mm/dd/yyyy)	**Time** (local)

SITE DESCRIPTION Photographic verification Y/N:
(bivalve abundance; collection method; access; permits; safety issues; tide & current; sea state; weather; sources; etc)

STATION LOCATION			
GPS:	Station 1	Station 2	Station 3
Latitude (decimal degrees)			
Longitude (decimal degrees)			
Water Depth (meters)			
Tidal Horizon (meters)			

WATER QUALITY				
Instrument:		Station 1	Station 2	Station 3
Temperature (C)	Surface			
	Bottom-0.5m			
Salinity (ppt)	Surface			
	Bottom-0.5m			
Specific Conductance (mS/cm^3)	Surface			
	Bottom-0.5m			
Dissolved Oxygen (mg/L)	Surface			
	Bottom-0.5m			
Secchi Depth (ft or m)				

Other Comments:

Southern California Coastal Water Research Project

3535 Harbor Blvd. Suite 110
Costa Mesa, CA 92626-1437
(714) 755-3200 Fax (714) 755-3299

Chain of Custody

Date 11/30/09 Page 1 of 1

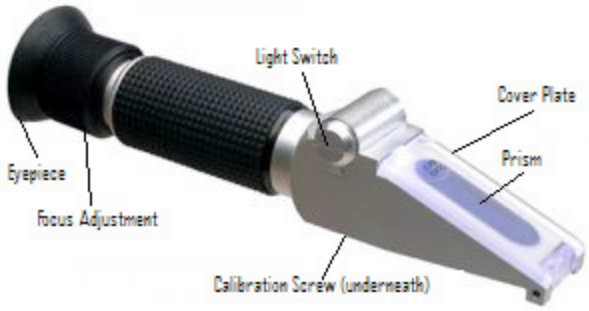
Sample Collection By: DARIO DIEHL & DAVID TSUKADA | Project Name: NOAA MUSSEL WATCH | Project Number: D3239

	Sample ID	Date	Time	Matrix	Container Type	Number of Containers	Comments	Analysis
✓	SBSB - #A	11/30/09	14:00	MUSSELS	PLASTIC BAG	1	ARCHIVE	CHEMISTRY
✓	SBSB - #B	"	13:45	"	"	1	"	"
✓	SBSB - #C	"	14:15	"	"	1	"	"
✓	SBSB - #H	"	13:45 to 14:15	"	"	1	"	"
✓	SBSB - EXTRA	"	1345→1415	"	"	1	"	"
✓	SBSB - SALINITY	"	14:35	SEA WATER	PLASTIC BOTTLE	1	"	SALINITY

Relinquished By		Relinquished By		Relinquished By	
(Signature) Dario Diehl	(Date) 12/1/09	(Signature)	(Date)	(Signature)	(Date)
(Printed Name) DARIO DIEHL	(Time) 1200	(Printed Name)	(Time)	(Printed Name)	(Time)
(Company) SCCWRP		(Company)		(Company)	
Received By		**Received By**		**Received By**	
(Signature) Amanda Fryer	(Date) 12/02/09	(Signature)	(Date)	(Signature)	(Date)
(Printed Name) Amanda Fryer	(Time) 900	(Printed Name)	(Time)	(Printed Name)	(Time)
(Company) B:B Laboratories		(Company)		(Company)	

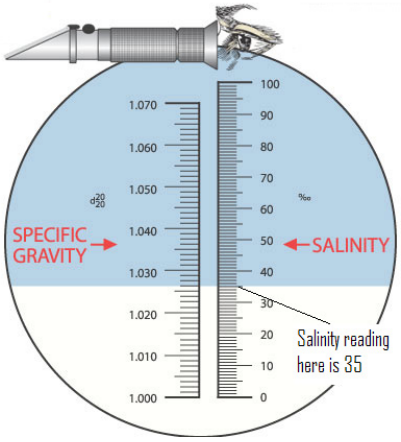
APPENDIX 3 – Measuring Salinity of Seawater using a Refractometer

Refractometer Parts



1. Verify that the refractometer has been calibrated by testing to see if distilled water reads as zero (0) - see calibration instructions below.
2. Open cover plate, use dropper from case to place several drops of seawater* on clean prism surface, gently close cover plate and press lightly so seawater spreads across entire surface of prism without air bubbles or dry spots. Obtain seawater from middle of water column (not at surface) in as deep water as your boots allow you to wade (i.e. 1 – 2 feet of water).
3. Allow seawater to remain on prism for approximately 30 seconds, keeping refractometer level so as not to drain seawater away.
4. Turn on light switch to illuminate prism and look into the eyepiece. Note on the RIGHT side of the scale (o/oo PPT - Salinity) where the white and blue boundary lies. This value is the salinity reading. Focus using the focus adjustment just in front of the eyepiece.
5. After measurement, clean away the seawater on the surface of the prism and cover plate using a cloth or paper towel. Put it back into its container after it is dry and store in safe location.

Calibration Instructions for Refractometer:



1. Obtain distilled water in a closed vial and place in a seawater bath to bring distilled water to approximately the same temperature as the seawater you will be measuring should take ~ 3-5 minutes.
2. Removed distilled water vial from seawater bath and wipe outside of vial dry, so as not to contaminate with seawater droplets.
3. Open refractometer cover plate, use dropper from case to place several drops of DISTILLED water on clean prism surface, gently close cover plate and press lightly so water spreads across entire surface of prism without air bubbles or dry spots.
4. Allow distilled water to remain on prism for approximately 30 seconds, keeping refractometer

level so as not to drain water away.

5. Turn on light switch to illuminate prism, look into refractometer and find where the white and blue boundary lies.

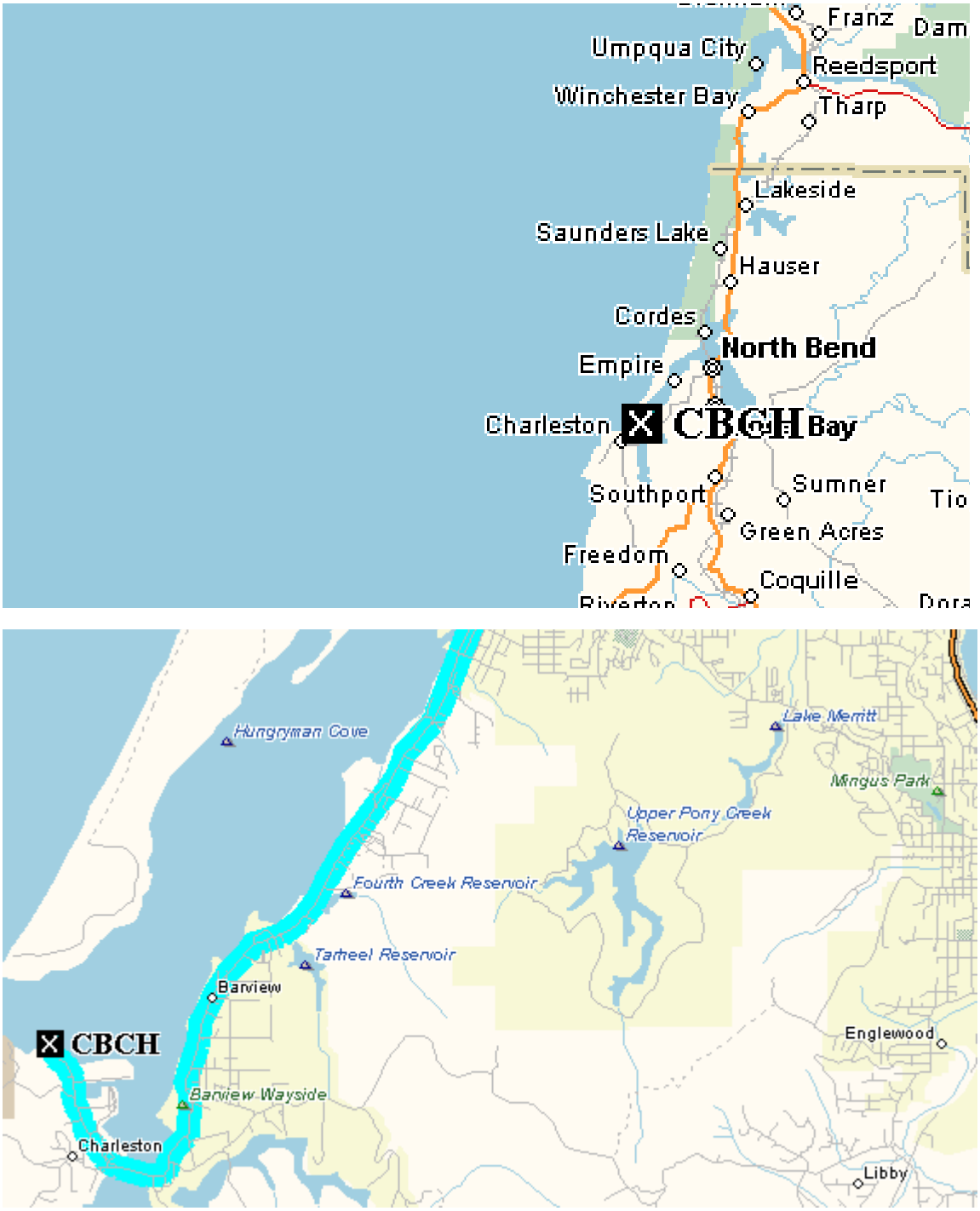
a. Focus the scale using the focus adjustment near the eyepiece.

6. Use small screwdriver in refractometer case to adjust calibration screw under prism until the white and blue boundary is just on the zero (0) mark.

7. After calibration, clean away the water on the surface of the prism and cover plate using a cloth or paper towel. You are now ready to take a salinity reading of seawater…follow directions above.

Appendix 4 - Site Description

OREGON SITES



Map indicating location of Coos Head, Coos Bay (CBCH).

COOS HEAD, COOS BAY (CBCH)

TARGET SPECIES - *Mytilus californianus*
NOMINAL SITE CENTER - 43° 21.00' N 124° 19.85' W

SITE ACCESS - The site is located on the jetty at the Oregon Institute of Marine Biology, which used to be the old Coos Head Coast Guard Station. From Highway 101 in Coos Bay, turn west onto Newmark Rd. and drive to the end. Then go south (left) onto South Empire Road/Cape Arago Highway and follow the road for about 4.5 miles down to Charlestown. Cross over the bridge into the town and take the first right onto Boat Basin Road/Coos Head Road. Follow the road to the end and then into the old Coast Guard Station grounds. The Institute Administration building is on the left hand side of the road before the old USCG station. Permission should be obtained from the laboratory director for access to the site, which is now on the Institute's grounds. If sediments are to be collected, a boat is needed to access the sediment site. There is a good public boat ramp at North Bend, next to the Municipal Airport.

SITE DESCRIPTION - The bivalve site is located on the jetty at the Oregon Institute of Marine Biology, which used to be the old Coos Head Coast Guard Station. The discrete stations are located on the concrete pilings under the jetty.

BIVALVE COLLECTIONS

1995 No collection.

1996 The site was sampled under adverse weather conditions, just after a 100 year winter storm. Discrete sampling stations were not collected, as the waves and wind conditions were very high, and there was only a few mussels to be found higher up the intertidal zone. Medium sized *M. californianus* mussels were collected for the analysis. Collected mussels ranged from 5.8 cm to 8.0 cm in shell length. The average shell length was 7.0 cm with a standard deviation of 0.6 cm for 21 collected individuals.

1997 No collection.

1998 *M. californianus* mussels were collected at Stations 2 and 3 (2cd and 3rd pilings) only due to the presence of tar on the 1st piling. The mussels were abundant at this site. Collected mussels ranged from 5.0 cm to 10.8 cm in shell length. The average shell length was 7.9 cm with a standard deviation of 1.7 cm for 19 collected individuals.

1999 No collection.

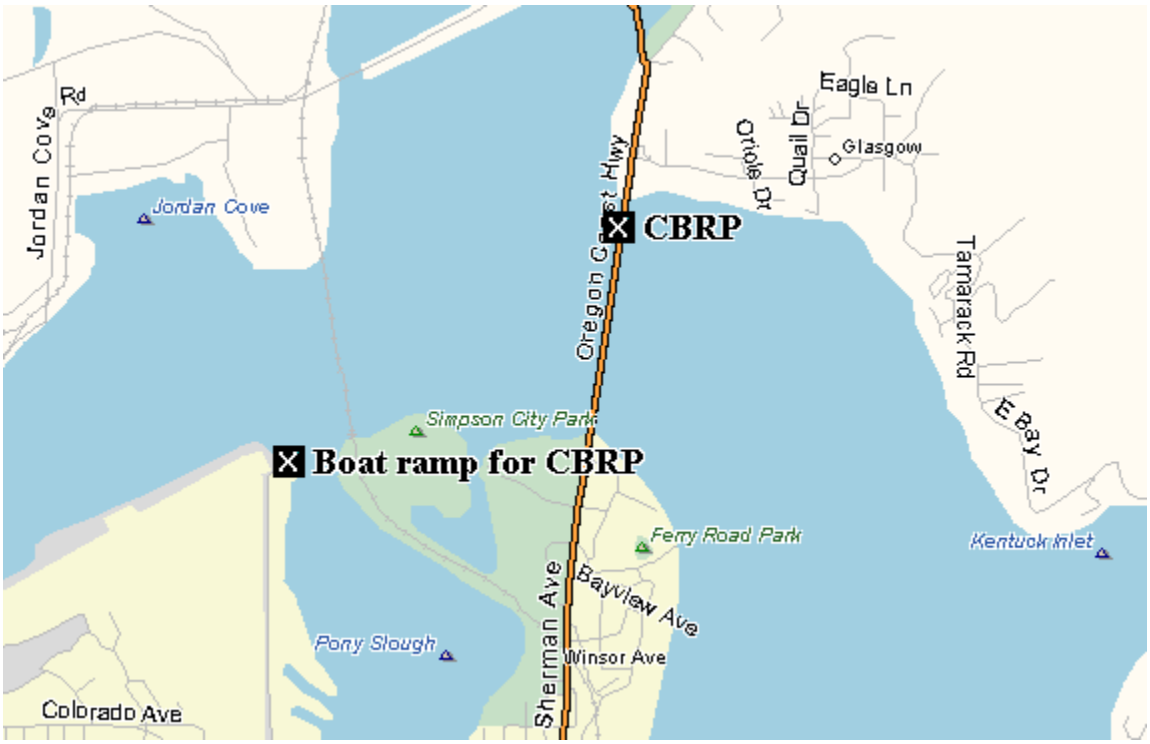
2000 Large sized M. californianus mussels were very abundant at all stations at this site.

2008 Mussels were collected

SAMPLING METHODS
Bivalves - hand

WATER DEPTH - intertidal, +0.5 m MLLW.

POSSIBLE CONTAMINANTS – There is no obvious point source of contamination aside from some creosoted pilings.



Map indicating location of Russell Point, Coos Bay (CBRP).

RUSSELL POINT, COOS BAY (CBRP)

TARGET SPECIES – *Mytilus trossullus/galloprovincials*

NOMINAL SITE CENTER - 43° 25.88’ N 124° 13.27’ W

SITE ACCESS - This site is located under the Highway 101 bridge across Coos Bay, just to the north of North Bend. Access is via private property. To reach the site, turn east onto East Bay Drive, just north of the Highway 101 bridge over Coos Bay (connecting Russell Point to North Point). On East Bay Drive, turn right onto the first private driveway. If sediments are to be collected, a boat is needed to access the sediment site. There is a good public boat ramp at North Bend, to the northeast of the Municipal Airport. Access to the ramp is via California St. Follow the sign to the ramp. It is also easier to sample the bivalve site from a small boat.

SITE DESCRIPTION – The target location is the 8th, 9th, and 10th bridge supports counting from the north end of the bridge. No farther than the 7th bridge support is accessible without a boat, and mussels are not always present on the 7th support. Collections have been pooled from the more northerly supports without designating three discrete collection stations when collecting without using a boat.

BIVALVE COLLECTIONS

1995 *M. edulis* was collected from this site, although it was uncommon. Oysters (*Crassostrea gigas*) were also present, but uncommon. Collected mussels ranged from 3.8 cm to 6.0 cm in shell length. The average shell length was 4.6 cm with a standard deviation of 0.5 cm for 39 collected individuals.

1996 During the 1996 field season, there was a small population of small *M. edulis* mussels growing on the concrete bridge pilings, and on the rocks around the bases of the pilings. The discrete stations were located on the 1st, 2nd and 3rd pilings north of the green mid-section of the bridge. Collected mussels ranged from 2.6 cm to 4.2 cm in shell length. The average shell length was 3.2 cm with a standard deviation of 0.3 cm for 89 collected individuals.

1997 No collection.

1998 The 4th bridge piling was sampled without designating discrete stations, *M. edulis* was the only species present at this site. There was a copious amount of dead mussels noted and the mussels were predominantly small sized. Collected mussels ranged from 1.9 cm to 5.1 cm in shell length. The average shell length was 2.9 cm with a standard deviation of 1.9 cm for 89 collected individuals.

1999 No collection.

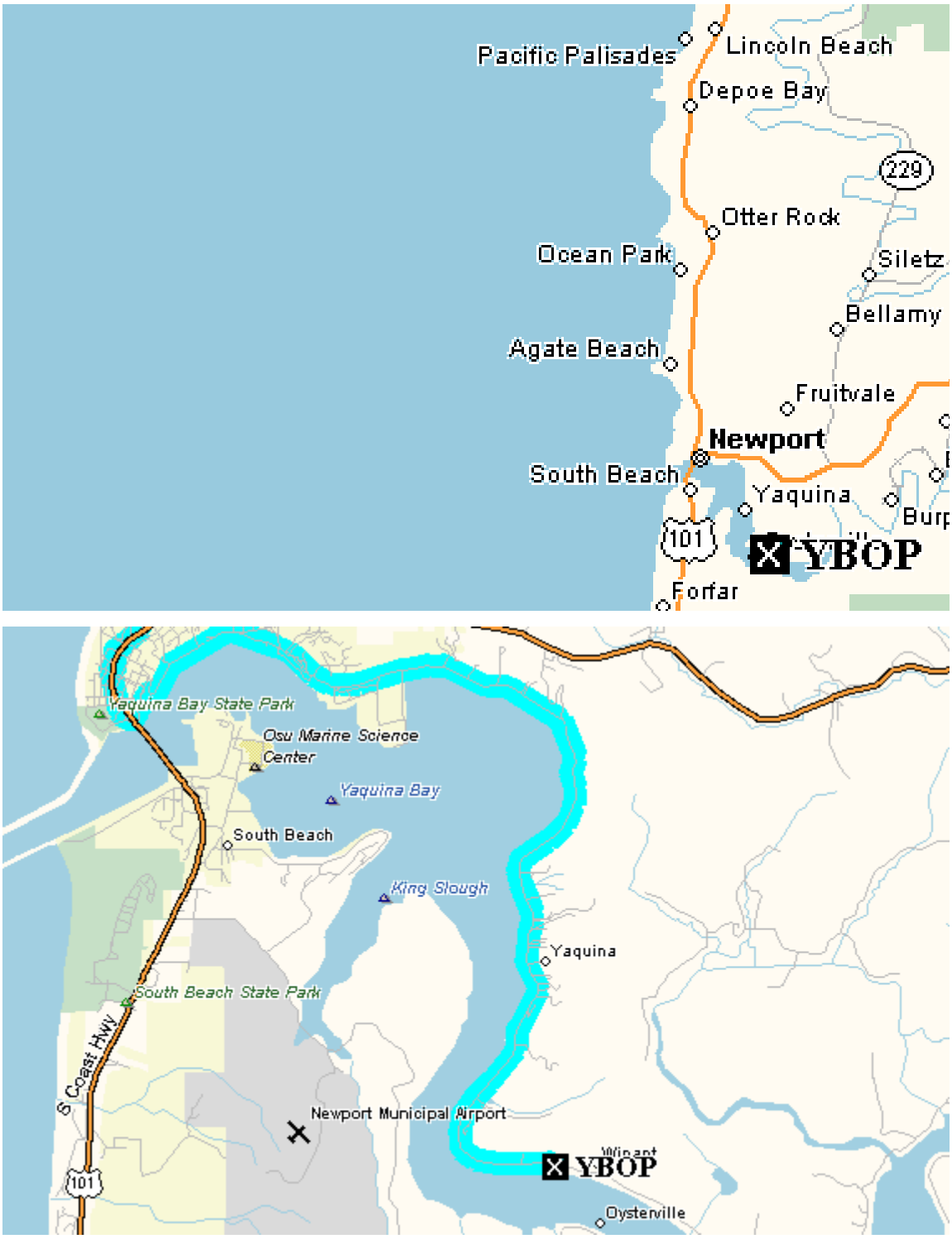
2000 Abundant medium sized (approx. 3.0 cm average) *M. edulis* mussels present at this site. The Pacific Oyster, Ostrea gigas, was also present and sampled at this location.

2008 Mussels were collected.

SAMPLING METHODS
Bivalves - hand

WATER DEPTH - intertidal, +0.5 m MLLW.

POSSIBLE CONTAMINANTS – Potential sources are from the lumber and fishing industries located in Coos Bay. The bridge and associated maintenance activities are another source of contamination.



Map indicating location of Oneatta Point, Yaquina Bay (YBOP).

ONEATTA POINT, YAQUINA BAY (YBOP)

TARGET SPECIES - *Mytilus trossullus/galloprovincials*

NOMINAL SITE CENTER - 44° 34.51’ N 123° 59.34’ W

SITE ACCESS - Mussels from this site are acquired from the Oregon Oyster Company, Inc., 6878 Yaquina Bay Rd., located on the north side of Yaquina Bay, approximately 7 miles east of Newport. Turn east from Highway 101 onto Yaquina Bay Rd. at the southern end of Newport, just north of the Highway 101 bridge over Yaquina Bay.

SITE DESCRIPTION - Mussels occur at this site through natural settlement onto commercially grown oysters. The oysters are cultured in mesh bags placed in floating wooden racks, which means that these mussels are never exposed to the atmosphere at low tide. The mussels are discarded into large bins along with empty oyster shells as the oysters are harvested and processed. Collections were made from mussels that had been removed from the water within a few hours.

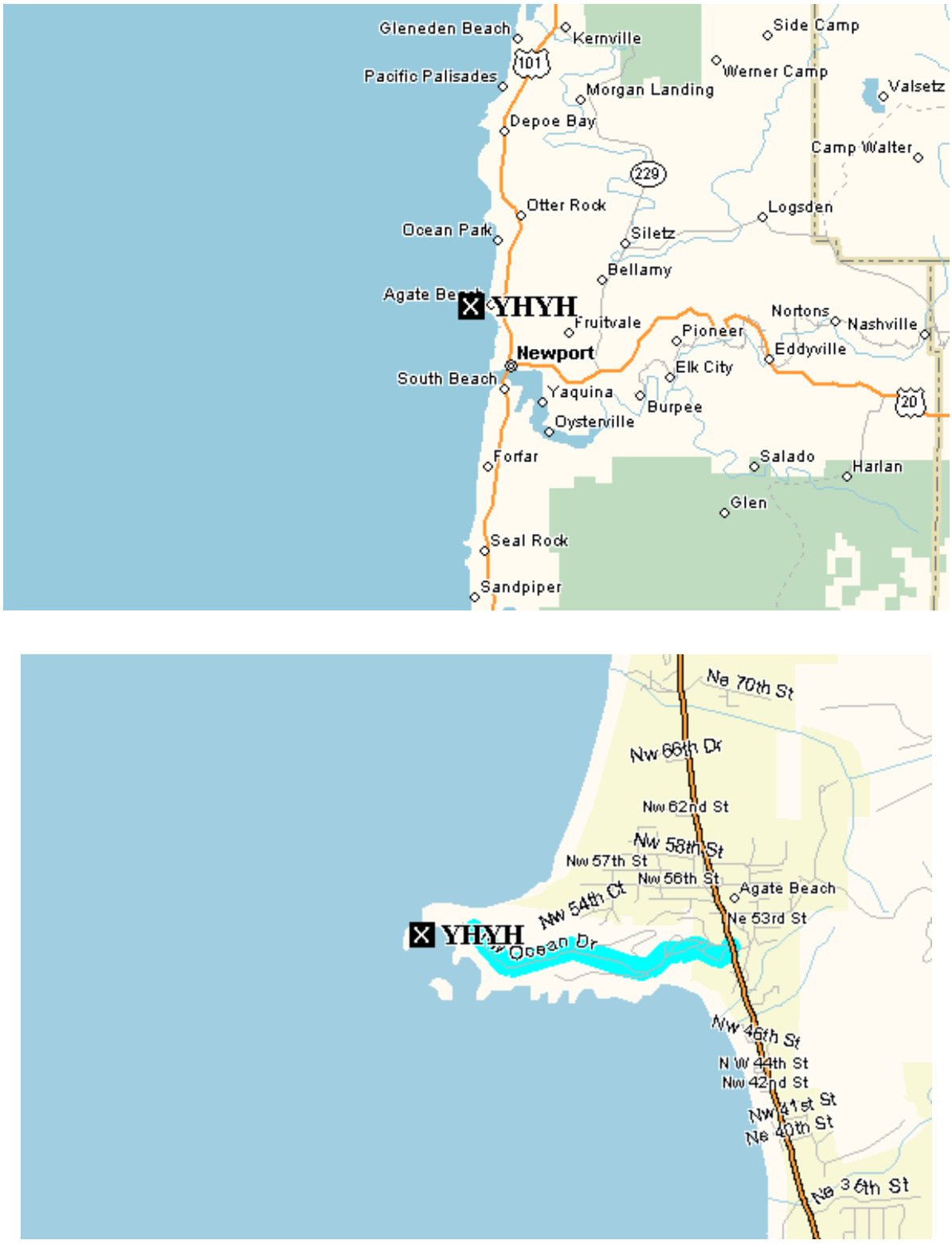
BIVALVE COLLECTIONS

1995 *M. californianus* was abundant. Cultured *Crassostrea gigas* and *Ostrea lurida* were also abundant at this site. Collected mussels ranged from 3.6 cm to 4.7 cm in shell length. The average shell length was 4.1 cm with a standard deviation of 0.3 cm for 41 collected individuals.
1996 No collection.
1997 *M. californianus* was abundant. Collected mussels ranged from 1.6 cm to 5.5 cm in shell length. The average shell length was 2.9 cm with a standard deviation of 0.7 cm for 57 collected individuals.
1998 No collection.
1999 *M. californianus* was abundant growing on commercially grown oysters. Mussels were collected from harvested oysters as a composite sample. Collected mussels ranged from 2.0 cm to 4.7 cm with an average shell length of 3.1 cm and a standard deviation of 0.7 cm for 144 individuals.
2000 No Collection
2009 Collected

SAMPLING METHODS
Bivalves - hand

WATER DEPTH - Not applicable.

POSSIBLE CONTAMINANTS – There is no obvious point source of contamination.



Map indicating location of Yaquina Head, Yaquina Bay (YHYH).

YAQUINA HEAD, YAQUINA BAY (YHYH)

NOMINAL SITE CENTER - 44° 40.58’ N 124° 04.68’ W

SITE ACCESS - For site access, turn off Highway 101 approximately 5 miles north of Newport at the sign to Yaquina Head. Park in the lot and go down the staircase to the beach directly below the lighthouse. Beware of high winds, surf and surging tide.

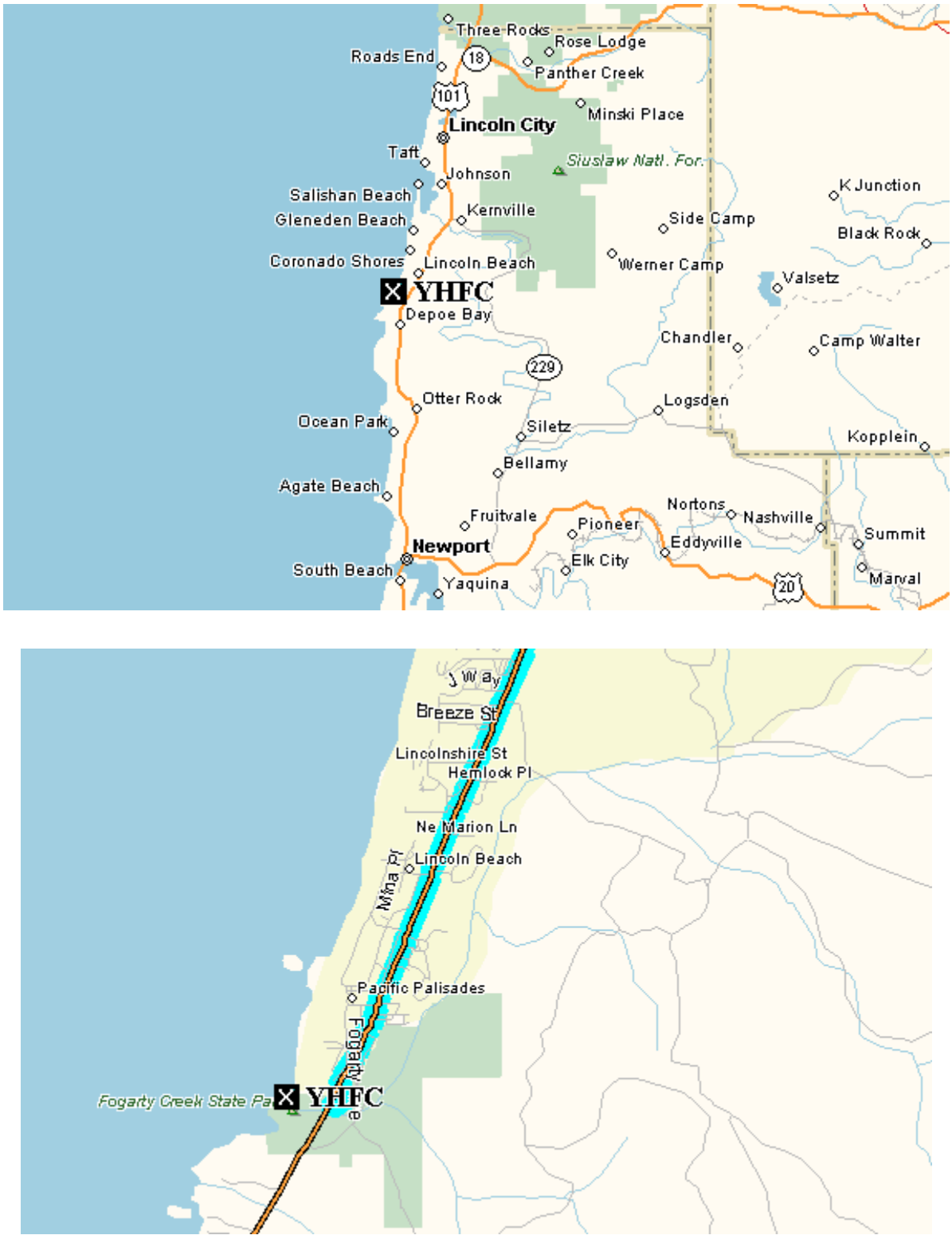
SITE DESCRIPTION - Mussels are found on rocks south of the tip of Yaquina Head.
For sediment collection, launch at Rivers Bend Marina. Travel downriver to Sally’s Slough and sample near the entrance to the north of the dredged channel.

This site is no longer sampled because it was categorized in 1992 as a Marine Garden by the Oregon Department of Fish and Game.

BIVALVE COLLECTIONS
1995 No collection.
1996 No collection.
1997 No collection.
1998 No collection.
1999 No collection.
2000 No collection.

SAMPLING METHODS
Bivalves - Intertidal, hand collection

WATER DEPTH - 2.5 m
POSSIBLE CONTAMINANTS – There is no obvious point source of contamination.



Map indicating location of Fogarty Creek, Yaquina Bay (YHFC).

FOGARTY CREEK, YAQUINA BAY (YHFC)

TARGET SPECIES - *Mytilus californianus*
NOMINAL SITE CENTER - 44° 50.22’ N 124° 03.12’ W

SITE ACCESS - This site has replaced the original site at Yaquina Head (YHYH). This site (YHFC) is located adjacent to the mouth of Fogarty Creek near Yaquina Head. It is an open-coast site, not actually on Yaquina Bay as the name suggests. Fogarty Creek empties into the ocean approximately 2 miles north of the town of Depoe Bay, which is approximately 20 miles north of Newport. Take Highway 101 to the Fogarty Creek State Park parking lot located on the east side of Highway 101. From the parking lot, follow the signs to the beach. The trail to the beach runs along the south side of Fogarty Creek, and crosses under the Highway 101 bridge over the creek. From the trail under the southwest corner of the bridge, the site is approximately 300 m west-southwest.

SITE DESCRIPTION - The site center is a large tide pool on the west side of a prominent large group of rocks that can be accessed only near low tide. The rocks are located at the water’s edge (at low tide) just south of where Fogarty Creek runs into the ocean (this may change over time) approximately 300 m from the end of the southern trail under the bridge. Collections were made from three discrete stations. The middle station was at the site center and two other discrete stations were located approximately 10 m north and south of the middle station.

BIVALVE COLLECTIONS

1995 *M. californianus* was abundant. This site is very exposed and is hazardous during heavy surf conditions. Collected mussels ranged from 3.8 cm to 6.9 cm in shell length. The average shell length was 5.5 cm with a standard deviation of 0.8 cm for 36 collected individuals.

1996 No collection.

1997 *M. californianus* was abundant at this site. Collected organisms were cut from the vertical rock surfaces during low water intervals between wave sets. This site is very exposed and is hazardous during heavy surf conditions. Collections must be made at low tide. Collected mussels ranged from 2.3 cm to 5.5 cm in shell length. The average shell length was 4.0 cm with a standard deviation of 0.7 cm for 42 collected individuals.

1998 No collection.

1999 The center of the site was a large tide pool on the west side of a large prominent group of rocks that must be sampled at low tide. *M. californianus* were heavily encrusted with barnacles and collected on the vertical face of the rocks from three walls surrounding the tide pool. Collected mussels ranged from 2.8 cm to 6.2 cm, 2.1 cm to 6.7 cm, and 2.0 cm to 7.3 cm for Stations 1, 2 and 3 respectively. The average shell length, standard deviation, and number of individuals for Stations 1, 2, 3 follow: 4.0 cm, 1.0 cm, and 26 (Station 1); 4.4 cm, 1.2 cm, and 24 (Station 2); 4.4 cm, 1.2 cm, and 24 (Station 3).

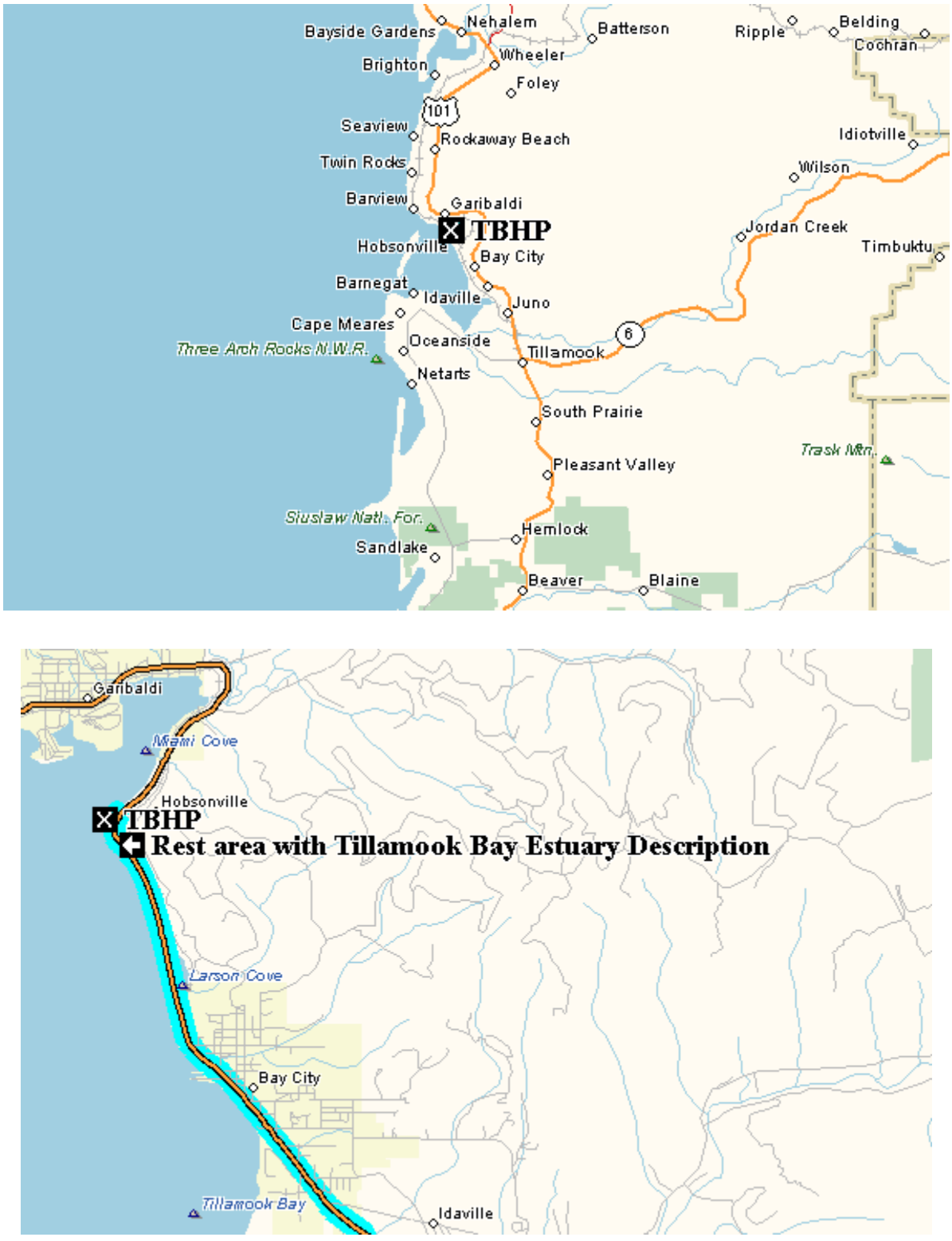
2000 No collection.

2009 collected

SAMPLING METHODS
Bivalves - hand

WATER DEPTH - intertidal, +1.5 m MLLW.

POSSIBLE CONTAMINANTS – There is no obvious point source of contamination. The watershed of Fogarty Creek receives agricultural runoff.



Map indicating location of Hobsonville Point, Tillamook Bay (TBHP).

HOBSONVILLE POINT, TILLAMOOK BAY (TBHP)

TARGET SPECIES - *Mytilus trossullus/galloprovincials*

NOMINAL SITE CENTER - 45° 32.83’ N 123° 54.45’ W

SITE ACCESS - This site is located approximately 4 miles south of the town of Garibaldi, Oregon, adjacent to Highway 101. The parking area is the first left turn north of the clearly marked rest area with a Tillamook Bay Estuary descriptive sign in the parking area jutting out into the bay. The sampling location is the point that juts out to the north of the rest area. The parking area for the sampling site has no sign that would indicate when to turn, however it is the first left turn (a discrete driveway that opens into a wooded parking area) north of the rest area. Take the trail southwest approximately 200 m to the southwest tip of Hobsonville Point.

SITE DESCRIPTION - The site center is the southwest tip of Hobsonville Point. Mussels are collected from concrete boulders that are exposed during low tidal periods. Concrete boulders located approximately 15 m on either side of the site center are designated Stations 1 and 3 respectively.

BIVALVE COLLECTIONS

1995 *M. edulis* was somewhat sparse. Collected organisms were heavily fouled by barnacles. Collected mussels ranged from 3.6 cm to 5.3 cm in shell length. The average shell length was 4.3 cm with a standard deviation of 0.4 cm for 35 collected individuals.

1996 No collection.

1997 *M. edulis* were quite abundant at Hobsonville Point, but the specimens were rather small. Most of the organisms were thickly encrusted with barnacles. Collected mussels ranged from 2.0 cm to 4.8 cm in shell length. The average shell length was 3.2 cm with a standard deviation of 0.7 cm for 66 collected individuals.

1998 No collection.

1999 *M. edulis* were abundant at all stations, small sized and heavily encrusted with barnacles. Collected mussels ranged from 1.9 cm to 3.6 cm, 2.2 cm to 4.6 cm, and 2.2 cm to 4.8 cm for Stations 1, 2 and 3 respectively. The average shell length, standard deviation, and number of individuals for Stations 1, 2, 3 follow: 2.6 cm, 0.4 cm, and 64 (Station 1); 3.4 cm, 0.6 cm, and 61 (Station 2); 3.1 cm, 0.5 cm, and 48 (Station 3).

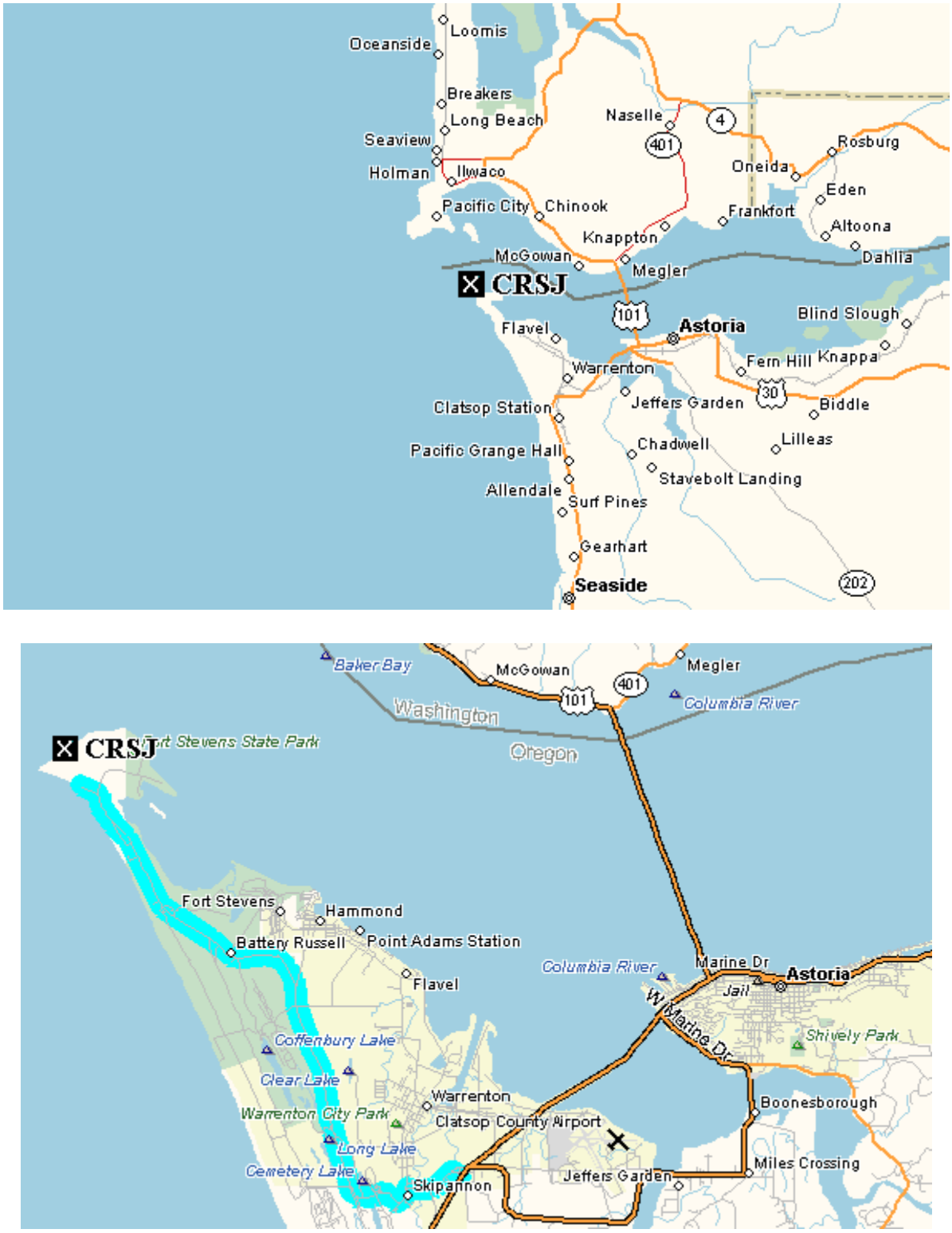
2000 No collection.

2009 Collected

SAMPLING METHODS
Bivalves - hand

WATER DEPTH - intertidal, +1.0 m MLLW.

POSSIBLE CONTAMINANTS – Potential sources of contamination include the lumber industry and the fishing industry in the town of Garibaldi.



Map indicating location of South Jetty, Columbia River (CRSJ).

SOUTH JETTY, COLUMBIA RIVER MOUTH (CRSJ)

TARGET SPECIES - *Mytilus trossullus/galloprovincials*

NOMINAL SITE CENTER - 46° 13.72’ N 124° 01.39’ W

SITE ACCESS - This site is located on the south jetty at the mouth of the Columbia River. From Astoria, drive south on Highway 101 across Youngs Bay. Take a right onto Fort Stevens Highway and follow the signs to parking lot C. Park the car in the southwest corner of the lot and take the trail beginning at that corner across the cordgrass to the sandflats on the north side of the jetty. The site is about 1/2 mile out the jetty, past where the cordgrass stops and the sand flats intersect the jetty. The sand flats are exposed for a considerable expanse at low tide, and it is only possible to collect mussels during this low tide exposure, as the mussels are limited to a very narrow horizon at the sand/jetty interface. It is easy and safe to collect at night if the tide is out.

Precautions - The entrance to the Columbia River is one of the most dangerous harbor entrances in the world due to high swells, high tidal and river flow, and bars which create an extraordinary environment of breaking waves across the entrance. The extreme energy of the environment is witnessed by the number of very large logs/driftwood that are perched atop the jetty some 20-30 feet above the sea surface, having been thrown there by the surf. Extreme caution should be used in sampling this site as large waves frequently crash over the jetty and onto the river side. Care also should be taken when approaching the site because there are areas of very soft sand which are exposed at low tide. The rock rubble of the jetty is not amenable to climbing and there is no walkway or path on top of the jetty. Access to the site is only possible by walking the sand flats on the north side of the jetty at low (or receding) tide.

SITE DESCRIPTION - The site center is approximately where the sand flats abutting the jetty at low tide end and the bay precludes further advance out the jetty. The mussels are found in very dense mats of small individuals. The patches are not ubiquitous but can be easily found in the cervices between rocks at the sand/rock interface.

BIVALVE COLLECTIONS

1995 *M. edulis* occurred in extensive mats covering large surfaces of the jetty’s base rocks, although they were small. Collected organisms ranged from approximately 1.0 – 2.0 cm in shell length.

1996 No collection.

1997 *M. edulis* were collected at the seaward end of the sand flat on the north side of the jetty at low tide. Individuals were small, and no large individuals were in evidence anywhere near the site. Collected mussels ranged from 1.2 cm to 3.8 cm in shell length. The average shell length was 2.1 cm with a standard deviation of 0.5 cm for 310 collected individuals.

1998 No collection.

1999 *M. edulis* were collected at the jetty base from dense mats of small individuals. There were three discrete stations sampled, Station 2 at the target coordinates and Station 1 and 3 approximately 30 m on either side of Station 2 along the jetty base. Collected mussels ranged from 1.5 cm to 3.2 cm, 1.4 cm to 2.5 cm, and 1.5 cm to 3.2 cm for Stations 1, 2 and 3 respectively. The average shell length, standard deviation, and number of individuals for Stations 1, 2, 3 follow: 2.2 cm, 0.3 cm, and 221 (Station 1); 1.7 cm, 0.2 cm, and 189 (Station 2); 2.1 cm, 0.3 cm, and 217 (Station 3).

2000 No collection.

2009 Mussels were 1 / 2 to 1 inch in length and located in small tight groups. Samples from 3 locations were taken.

SAMPLING METHODS
Bivalves - hand

WATER DEPTH - intertidal, 0.0 MLLW.

POSSIBLE CONTAMINANTS – The Columbia river watershed includes a vast area of rural/agricultural and urban/industrial areas.

U.S. Department of Commerce
Wilbur Ross, *Secretary*

National Oceanic and Atmospheric Administration
Tim Gallaudet, RDML (Ret.), *Administrator*

National Ocean Service
Nicole R. LeBoeuf, *Acting Assistant Administrator*

The mission of the National Centers for Coastal Ocean Science is to provide managers with scientific information and tools needed to balance society's environmental, social and economic goals. For more information, visit: http://www.coastalscience.noaa.gov/.